

Original Article



Assessment of Psychological Status in Erythrophobia Patients before and after Endoscopic Thoracic Sympathectomy

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Abstract:

Background: Erythrophobia is a psychiatric disorder characterized by social anxiety triggered by facial blushing. It does not respond to pharmacological and psychological interventions for many patients with erythrophobia. Endoscopic thoracic sympathectomy (ETS) is an effective minimally invasive surgery for the treatment of erythrophobia. This study aims to assess the psychological status of patients with erythrophobia before and after ETS using standardized psychometric tools.

Methods: Erythrophobia patients treated by ETS in the Second Hospital of Anhui Medical University from June of 2019 to August of 2021 were enrolled. Electronic questionnaires and patient medical records were used to collect clinical data of patients, including sex, age, family history, body mass index (BMI), preoperative treatment history, postoperative improvement in facial blushing, compensatory hyperhidrosis (CH) and psychological status. The severity of CH was evaluated using the Hyperhidrosis Disease Severity Scale (HDSS). Psychological status was assessed by Self-Esteem Scale (SES), Social Avoidance and Distress Scale (SADS), Shyness Scale (SS) and Social Anxiety Scale (SAS).

Results: The overall efficacy rate of ETS was 95.1% (39 cases), with complete resolution of blushing in 70.7% (29 cases), partial resolution in 24.4% (10 cases), and no improvement in 4.9% (2 case). Their overall satisfaction was 85.4% (35 cases), wherein 53.7% (22 cases) reported a high level of satisfaction, 31.7% (13 cases) moderate satisfaction, and 7.3% (3 cases) dissatisfaction. Interference with daily activities due to CH (HDSS grades 3 and 4) occurred in 14.6% of patients, all of whom were HDSS grade 3. The most commonly of CH affected areas were the chest and back (87.8%). SES scores increased from 24.29 ± 2.462 (preoperative) to 28.73 ± 2.481 (postoperative), indicating a significant boost in self-esteem ($P < 0.001$). SADS scores were 21.12 ± 2.610 before the surgery and 17.71 ± 2.667 after the surgery, presenting a visible improvement ($P < 0.001$). SS scores decreased from 39.22 ± 6.393 to 33.80 ± 7.639 , showing significant improvement in shyness ($P < 0.001$). SAS scores decreased from 15.49 ± 3.835 to 12.98 ± 3.489 , indicating a reduction in social anxiety ($P = 0.003$).

Conclusion: ETS is an effective treatment for erythrophobia and it significantly improves the self-esteem, social avoidance and distress, shyness and social anxiety of patients.

Keywords: Erythrophobia; endoscopic thoracic sympathectomy; psychological status; compensatory hyperhidrosis; facial blushing

1. Introduction

Erythrophobia, also known as blushing phobia, is a social anxiety disorder caused by facial blushing and is classified as a psychiatric condition [1]. Patients are prone to facial or even whole-body blushing in response to emotional changes.

Blushed face has an influence on their perceived embarrassment, the sincerity of apologizing, and the possibility to be forgiven for inappropriate behaviors, thereby causing significant personal distress and impairing social functioning [2]. The most obvious symptoms are abnormal behaviors,

unexplained nervousness, blushing and timid interaction with others. Social anxiety disorder is a prominent manifestation of patients [3], and studies have shown a strong positive correlation between blushing and social anxiety [4]. The prevalence rate of this disease remains unclear [5]. The higher incidence among young people may be related to their anxious and sensitive adolescence and their increased social pressure [6]. It is slightly higher in females than in males with a tiny difference [7]. There is limited knowledge about the potential mechanism of blushing and a debate in the theory on whether it is a rapid and spontaneous emotional response without self-reflection or whether it is driven by more complex social cognition processes [8].

At present, the popular therapies contain psychological and behavioral interventions, medication and surgical treatment, of which surgical treatment is proved to be the most effective approach with a relatively low recurrence rate [9,10]. Endoscopic thoracic sympathectomy (ETS) has successfully treated patients with palmar hyperhidrosis in recent years, and thus it is applied to people with facial blushing. The therapeutic range of erythrophobia patients has been enlarged in the past decade with the long-term success rate and professional knowledge from more than 2 000 cases of palmar hyperhidrosis treatment by ETS. Standard mental assessment tools were chosen to assess the psychological status of patients in this study, so as to fully explore the feasibility of erythrophobia treatment by ETS.

Materials & Methods

General Data

Erythrophobia patients treated by ETS in the Second Hospital of Anhui Medical University from June of 2019 to August of 2021 were selected. The inclusion criteria were as follows: ① age between 18 and 50 years; ② possessing a strong negative influence on self-images, social life and working life; ③ having no response to pharmacological and psychological interventions. Exclusion criteria were as follows: ① blushing due to organic diseases; ② impaired cognitive or behavioral capacity; ③ coexisting major organ dysfunction; ④ uncontrolled pulmonary infection; ⑤ unwillingness to understand or accept compensatory hyperhidrosis (CH).

This study was approved by the Ethics Committee of the Second Affiliated Hospital of Anhui Medical University (PJ-YX2019-015). Patients Consent to Participate.

Treatment

Sympathetic chain ablation was performed under uniportal thoracoscopy. Non-intubated general anesthesia to preserve spontaneous breathing was adopted before the engagement of double-lumen laryngeal mask (Fig1 a). The patient was positioned in a semi-Fowler's position (also known as the beach chair position, Fig1 b) with both arms abducted at 90° and secured on arm boards to fully expose both axillae. Furthermore, the lower limbs were slightly elevated to prevent the body from sliding down, or safety straps were used if necessary. The surgery was first operated at the right side owing to the greater influence of sympathetic nerves at the left side on the heart. An incision of 1.0 cm was made between the third or fourth rib in the anterior axillary line with the close monitoring of pulse, heart rate and oxygen saturation (SpO₂). The surgery was paused immediately to recover ventilation or carry out lower tidal volume ventilation as SpO₂ dropped below 90%, and it should be continued after the increase in the index. Thoracoscope was used to observe structure inside the thoracic cavity (Fig1 c) when an insufflator was connected to produce artificial pneumothorax, so that perfectly collapsed lung tissue was fully exposed within the field. Once the lung was adequately collapsed, the thoracoscope was held in place while the trocar was removed. A monopolar electrocautery hook was then introduced through the incision (Fig1 d). After identifying the second rib and the corresponding sympathetic chain, the R2 sympathetic trunk was transected using the electrocautery hook. Both ends of the nerve were further cauterized to ensure separation, and approximately 2 cm of the nerve along the rib surface was coagulated to remove possible Kuntz bundles and communicating branches to minimize the risk of recurrence (Fig1 e). Subsequently, a suction machine was linked to suck air within the thoracic cavity and an anesthesiologist performed artificial ventilation on the patient to form negative pressure inside without indwelling thoracic drainage tube. The incision was treated with intradermal cosmetic suture by absorbable wound sutures (Fig1 f) and dressed with medicine.

Operative steps were the same at the left and right sides. All patients experienced conventional chest X-ray examination in the operating room after the

surgery to detect pneumothorax symptoms, and most were discharged the following day.

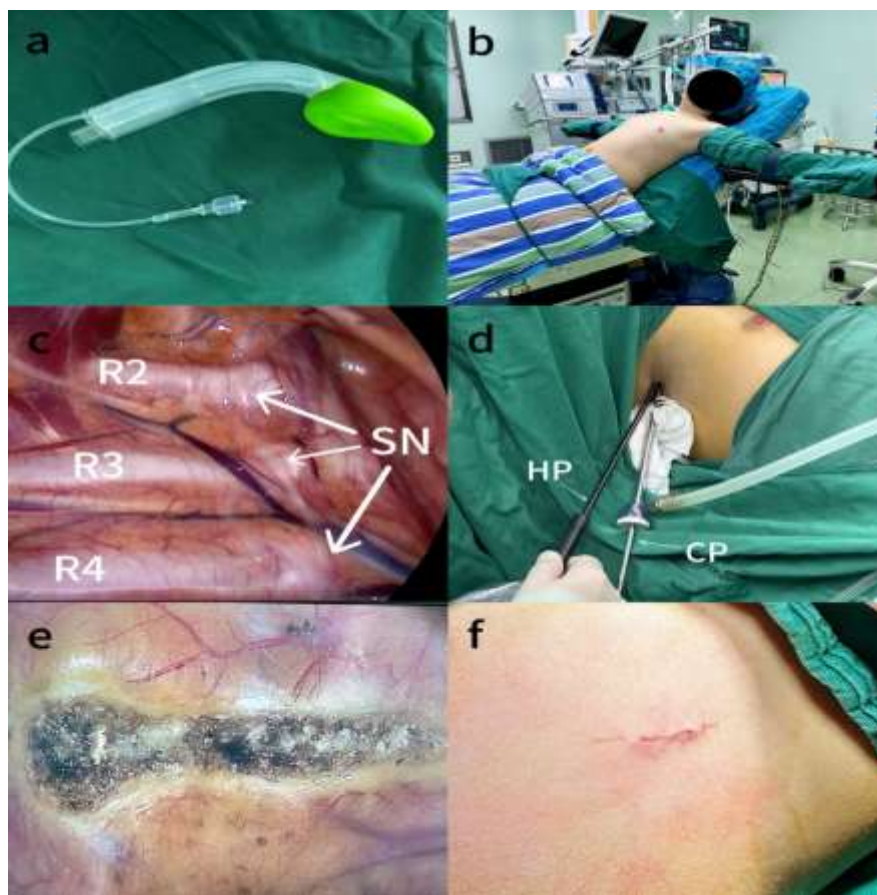


Figure 1 Surgical procedures of ETS. (a) Double-lumen laryngeal mask. (b) Fowler's position. (c) View within the thoracic cavity. (d) Introduction of electrocoagulation hook and thoracoscope to the same incision. (e) Post-cauterization view of the sympathetic nerve. (f) Intracutaneous cosmetic suture of the incision.

Collection of Patients' Clinical Data

Clinical data of patients were collected using electronic questionnaires and patient medical records, including sex, age, family history, body mass index (BMI), preoperative treatment history, postoperative improvement in facial blushing, psychological status, and CH. Postoperative CH grading was assessed using the Hyperhidrosis Disease Severity Scale (HDSS) [11]. Psychological status was assessed using scales. The Self-Esteem Scale (SES) [12] consists of 10 items using a four-point scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree). The total score ranges from 10 to 40 points, with higher scores indicating higher levels of self-esteem. The Social Avoidance and Distress Scale (SADS) [13] contains 28 items, with 14 items assessing social avoidance and 14 items

assessing social distress. Each item is scored using a binary "yes–no" format, with a total score of 0 indicating the lowest level of avoidance and distress, while a score of 28 indicating the highest level of severity. The Shyness Scale (SS) [14,15], which consists of 13 items, uses a five-point scoring system (1 = strongly disagree, 2 = disagree, 3 = uncertain, 4 = agree, 5 = strongly agree). The total score ranges from 13 (lowest shyness) to 65 (highest shyness). The Social Anxiety Scale (SAS) [16] contains 6 items, employing a five-point scoring system (0 = strongly disagree, 1 = somewhat disagree, 2 = uncertain, 3 = somewhat agree, 4 = strongly agree). Scores range from 0 (low levels of anxiety) to 24 (high levels of anxiety).

Electronic questionnaires were uniformly distributed and collected by researchers through the WeChat platform, with each participant

assigned a unique code number to protect patient privacy. Following questionnaire collection, researchers screened submissions based on completeness and accuracy of content. Invalid questionnaires were excluded before data entry, organization, and analysis. When discrepancies arose between questionnaire results and medical records, priority was given to information from medical records to minimize the impact of patient subjective bias on study outcomes.

Statistical Methods

Data processing and analysis were performed via SPSS 26.0. Patient characteristics were analyzed using descriptive statistics. Normally distributed continuous data were expressed as mean $\pm$ standard deviation ($\bar{x} \pm s$) and analyzed using the Mann-Whitney U test or two-sample *t*-test. Categorical variables were expressed as frequency and percentage (%) and compared using the χ^2 test or Fisher's exact test. $P < 0.05$ was considered statistically significant.

Results

General data of Patients

A total of 47 questionnaires were distributed and 41 valid questionnaires were collected, yielding an effective response rate of 87.2%. Among the participants, 28 were female (68.3%) and 13 were male (31.7%), with a median age of 31 (20–42) years; 24 cases (58.5%) had isolated blushing, while 17 cases (41.5%) had primary hyperhidrosis combined with craniofacial, palmar, or plantar involvement; 38 cases (92.7%) exhibited emotional facial blushing, and 3 cases (7.3%) had persistent facial blushing. The mean BMI was 23.27 ± 3.33 kg/m² and all patients received preoperative pharmacological or psychological interventions. Most patients were discharged on postoperative day 2 (1–3 days). No patients developed Horner's syndrome, hemorrhage, pneumothorax, or infection. The median operative time was 17 (10–30) min, and the median anesthesia time was 32 (21–45) min (Table 1).

Table 1 General data of patients

Characteristic	Results
Age (y)	31 (20–42)
Sex(F/M)	28/13
Isolated blushing	24 (58.5%)
Merge primary hyperhidrosis	17 (41.5%)
Emotional blushing	38 (92.7%)
Persistent blushing	3 (7.3%)
BMI (kg/m ²)	23.27 ± 3.33
Hospital stay(d)	2 (1–3)
Operative time(min)	17 (10–30)

Data are presented as n (%) except where otherwise noted. F= female, M= male, BMI= body mass index.

ETS Postoperative Outcomes

As of June 2024, the median interval between sympathetic intervention and questionnaire administration was 48.5 (37.5–60.9) months. The overall postoperative effectiveness rate was 95.1% (39 cases), with complete resolution of blushing in 70.7% (29 cases), partial resolution in 24.4% (10

cases), and no improvement in 4.9% (2 case). The overall patient satisfaction rate was 85.4% (35 cases), including 53.7% (22 cases) reporting “very satisfied,” 31.7% (13 cases) “satisfied,” 7.3% (3 cases) “neutral,” and 7.3% (3 cases) “dissatisfied” (Table 2).

Table 2 Postoperative follow-up

Variable	Value n (%)
Improvement blushing	39 (95.1%)
Complete resolution	29 (70.7%)
Partial resolution	10 (24.4%)
No improvement	2 (4.9%)

Overall satisfaction	35 (85.4%)
Very satisfied	22 (53.7%)
Satisfied	13 (31.7%)
Neutral	3 (7.3%)
Dissatisfied	2 (4.9%)
Very dissatisfied	1 (2.4%)

Postoperative CH

All 41 patients reported CH after ETS. CH interfering with daily activities (HDSS grades 3 and 4) occurred in 14.6% of patients, with HDSS 3 and HDSS 4 incidence rates of 14.6% and 0%,

respectively (Table 3). The anatomical distribution of CH was predominantly chest/back (87.8%), followed by abdomen, waist, groin, buttocks, and thighs, with less frequent involvement of popliteal fossa, calves, and feet.

Table 3 Occurrence of compensatory hyperhidrosis

HDSS	Value n(%)
HDSS 1	8 (19.5%)
HDSS 2	27 (65.9%)
HDSS 3	6 (14.6%)
HDSS 4	0

HDSS = Hyperhidrosis Disease Severity Scale. HDSS 1 = my sweating is never noticeable and never interferes with my daily activities, HDSS 2 = my sweating is tolerable but sometimes interferes with my daily activities, HDSS 3 = my sweating is barely tolerable and frequently interferes with my daily activities, HDSS 4 = my sweating is intolerable and always interferes with my daily activities.

Psychological Status Assessment before and after ETS Treatment

The psychological status changes were evaluated from four dimensions: self-esteem, social anxiety, shyness, and social avoidance/distress. SES scores increased from 24.29 ± 2.462 (preoperative) to 28.73 ± 2.481 (postoperative), indicating a

significant boost in self-esteem. SADS scores were 21.12 ± 2.610 before the surgery and 17.71 ± 2.667 after the surgery, presenting a visible improvement. SS scores decreased from 39.22 ± 6.393 to 33.80 ± 7.639 , showing significant improvement in shyness. SAS scores decreased from 15.49 ± 3.835 to 12.98 ± 3.489 , indicating a reduction in social anxiety (Table 4).

Table 4 psychological status of patients with erythrophobia before and after ETS

Scale	Preoperative	Postoperative	<i>t</i>	<i>P</i>
SES	24.29 ± 2.462	28.73 ± 2.481	8.133	<0.001
SADS	21.12 ± 2.610	17.71 ± 2.667	5.860	<0.001
SS	39.22 ± 6.393	33.80 ± 7.639	3.480	<0.001
SAS	15.49 ± 3.835	12.98 ± 3.489	3.103	0.003

SES=self-esteem scale, SADS=social avoidance and distress scale, SS=shyness scale, SAS= social anxiety scale.

Discussion

Erythrophobia is a neurotic disorder caused by facial blushing, where blushing acts as the core trigger for anxiety. Additionally, the etiology of blushing remains inconclusive to date. First, patients often exhibit hyperactivity of the autonomic nervous system, particularly

sympathetic hyperactivity, resulting in excessive sensitivity to external stimuli. Under such conditions, even mild social interactions or emotional fluctuations may induce excessive dilatation of facial blood vessels, leading to prominent neurovascular dilatation responses. This reaction is not only physiological but also constitutes a significant source of

patients' subjective anxiety experiences, frequently acting as a precipitating factor for patients' social avoidance behaviors [17]. In addition, genetic predisposition may play a role in pathogenesis, with some studies demonstrating familial clustering patterns of facial blushing [18]. Second, psychological factors are equally crucial in the onset and progression of this disorder. Many patients present with comorbid social anxiety disorder, exhibiting heightened sensitivity to others' attention and negative evaluations, accompanied by pronounced self-focused attention and negative cognitive bias, which easily forms a vicious cycle of "blushing–fear–increased blushing"[19]. Some individuals experienced mockery or criticism due to blushing during childhood or adolescence, and such negative social experiences may act as psychological roots for erythrophobia [20]. Comprehensively, erythrophobia is an anxiety disorder resulting from interactions among biological-psychological-social multifactorial components.

Treatment options for erythrophobia remain limited. Selective serotonin reuptake inhibitors have been proposed to reduce blushing and social phobia. Nonetheless, only few studies have specifically investigated their effects on the symptom of blushing itself [21]. Small-scale studies suggest successful application of psychological therapies such as cognitive-behavioral therapy for blushing improvement; however, psychotherapy is often time-consuming and yields transient therapeutic effects [22, 23]. Consequently, ETS treatment for blushing is considered an attractive and permanent solution [6]. Kuijpers *et al.* [24] reported 100% postoperative satisfaction among blushing patients. Dittberner *et al.* [10] documented satisfactory outcomes in 82% of 100 blushing patients treated with ETS. R2 sympathicotomy should be considered the primary treatment option for facial blushing [24, 25]. Literature reports indicate that compared with R2-R3 sympathicotomy, R2 sympathicotomy demonstrates remarkably superior local outcomes, with patients undergoing R2 sympathicotomy exhibiting markedly higher satisfaction rates. No significant differences were observed in their quality of life, CH rates, or blushing recurrence rates [10]. This study exclusively employed R2 sympathicotomy, achieving an overall postoperative effectiveness rate of 95.1% (39

cases), including complete resolution of blushing in 70.7% (29 cases), partial resolution in 24.4% (10 cases), and no improvement in 4.9% (2 case). The overall patient satisfaction rate reached 85.4% (35 cases), categorized as "very satisfied" in 53.7% (22 cases), "satisfied" in 31.7% (13 cases), "neutral" in 7.3% (3 cases), and "dissatisfied" in 7.3% (3 cases). Consistent with literature reports, these findings confirm R2 sympathicotomy as a preferable choice. The study attempted to identify which blushing subtypes benefit most from surgery. Moreover, emotional facial erythema has been established as a definitive indication for ETS, with favorable long-term outcomes anticipated [26]. Among the 33 cases of emotional facial erythema in this study, all achieved effectiveness, whereas 1 of the 2 cases with persistent facial erythema showed no improvement. Due to the limited case numbers, the efficacy for persistent facial erythema remains inconclusive. CH is the primary postoperative complication and one of the main causes of patient dissatisfaction. It has been reported that 99% of patients undergoing ETS develop CH [19]. In this study, all 41 patients reported CH after ETS. CH interfering with daily activities (HDSS 3 and 4) occurred in 14.6% of patients, all categorized as HDSS grade 3. CH is an irreversible complication, with no effective treatment available. Only a very limited number of reports suggest the possibility of sympathetic nerve reconstruction [27]. Current literature remains controversial regarding risk factors for CH development [28,29]. Isolated reports indicate that staged uniportal thoracoscopy R2 sympathicotomy (performing one side first, followed by the contralateral side after 4–6 months) may reduce CH incidence [30], potentially related to meticulous patient selection.

Self-esteem, a core construct in psychological literature, is theoretically and empirically linked to quality of life and mental health. It represents a direct estimation of positive or negative feelings toward the self. Low self-esteem manifests as negative self-attitudes, diminished self-acceptance and self-esteem, and reduced sense of self-worth [31]. The SES is the most commonly used questionnaire for assessing self-reported self-esteem. Scores below 25 indicate low self-esteem, 26–32 represent optimal levels, and scores above 33 suggest excessive self-esteem. Self-esteem influences social and emotional functioning,

emotion regulation, employment levels, quality of life, and neuropsychological deficits [32]. Low self-esteem can lead to depression, anxiety disorders, bipolar disorder, substance use disorders, and personality disorders [33, 34]. Preoperative scores of 24.29 ± 2.462 in patients indicated the presence of certain inferiority feelings, while postoperative scores increased to 28.73 ± 2.481 , achieving optimal self-esteem ($P < 0.001$). Social avoidance and distress refer to the tendency to avoid social interactions and the accompanying distress experienced in such situations. Avoidance constitutes a behavioral manifestation, whereas distress represents an emotional response. Social avoidance demonstrates a negative correlation with self-esteem [35]. Social anxiety is associated with intense fear of social evaluation and rejection, typically leading to avoidance behaviors and suffering. Social avoidance and distress constitute primary dimensions of social anxiety [36]. Reducing perceived stress and interpersonal alienation in blushing patients may serve as effective interventions for preventing and alleviating their social avoidance and distress. SADS scores were 21.12 ± 2.610 before the surgery and 17.71 ± 2.667 after the surgery, presenting an obvious improvement. The total score of the 13-item SS ranges from 13 (lowest level of shyness) to 65 (highest levels of shyness). Shyness is highly correlated with social avoidance/distress and social anxiety levels [37]. Additionally, patients with higher SS scorers also reported substantial subjective tension, suppression, and awkwardness during actual conversations [38]. The SS demonstrated preoperative scores of 39.22 ± 6.393 (indicating high shyness levels), which decreased to 33.80 ± 7.639 postoperatively, showing marked improvement in shyness ($P < 0.001$). The SAS was developed during the creation of the self-consciousness scale, measuring not only subjective anxiety but also difficulties in verbal expression and behavioral performance. The described scenarios include unfamiliar settings, being watched, embarrassing events, conversing with strangers, public speaking, and large gatherings. Social anxiety is characterized by intense fear of being judged in social situations. When this fear severely impairs daily functioning, it may lead to social anxiety disorder or social phobia [39]. Literature reports indicate that

endoscopic thoracic sympathectomy is associated with greater reductions in blushing and social phobia scale scores, along with higher treatment satisfaction [21]. In this study, patients demonstrated moderate improvement in postoperative social anxiety ($P = 0.003$).

Blushing involves acute blood accumulation in the superficial venous plexus of the skin, reflecting neurovascular dilatation responses controlled by the sympathetic branch of the autonomic nervous system. This physiological mechanism forms the rationale for ETS treatment selection [40]. This study demonstrates that ETS provides favorable improvements in both blushing and psychological status for patients with erythrophobia. Blushing could be a main culprit of fear for individuals diagnosed with social anxiety disorder. They avoid becoming the focus of attention, refrain from participating in situations that might expose personal vulnerabilities, and withdraw from social interactions. Nevertheless, the strength of association between blushing and negative/positive outcomes remains unclear. Therefore, patients require extremely cautious evaluation of the causal relationship between blushing and fear before opting for surgical intervention. Patient selection and thorough preoperative counseling are of paramount importance. The type of blushing must be carefully scrutinized. To be specific, in sympathectomy, the only blushing subtype demonstrating favorable responsiveness is the rapid-onset facial blushing that manifests within seconds. A critical prerequisite of accepting sympathectomy is that facial blushing must exert severe detrimental impacts on daily quality of life.

Conclusions

In conclusion, current evidence suggests that ETS treatment for erythrophobia is considered an attractive and permanent solution. However, severe CH remains a serious complication of ETS and stands to be another source of patient dissatisfaction or anxiety. Hence, comprehensive informed consent regarding patients' acceptance should be provided. Simultaneously, the selection of surgical approaches and exploration of CH risk factors still require further investigation. Furthermore, pharmacological and physiological treatment options must have been proven ineffective. Preoperative counseling holds utmost significance due to the elevated risk of side

effects. Surgeons should guide patients in making fully informed decisions regarding treatment options. Meanwhile, patients must receive exhaustive explanations about all advantages and disadvantages of sympathectomy to ensure realistic expectations regarding success rates, side effects, and complications. Patients should be explicitly informed that sympathectomy is inherently irreversible.

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Author Contributions

Xiao Zhou: study design, data analysis, drafting the manuscript and revision of the manuscript. Aosen Dong: data collection and analysis, drafting the manuscript, investigation. All authors read and approved the final version of the manuscript.

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Data Availability

All data generated or analyzed in this study are included in the present manuscript.

Competing of Interest Statement

All authors declared that there was no conflict of interest.

Consent for Publication

All authors have agreed to the publication.

Declarations

Patients Consent to Participate.

Ethics Approval Statement

This study was approved by the Ethics Committee of the Second Affiliated Hospital of Anhui Medical University (PJ-YX2019-015). Informed consent was waived for this retrospective

study due to the exclusive use of de-identified patient data, which posed no potential harm or impact on patient care.

Clinical Trial Number: not applicable.

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